US009163876B2

(12) **United States Patent**
Chiwata et al.

(10) **Patent No.: US 9,163,876 B2**
(45) **Date of Patent: Oct. 20, 2015**

(54) **DRYING DEVICE AND IMAGE FORMING APPARATUS**

(71) Applicant: **FUJIFILM CORPORATION**, Tokyo (JP)

(72) Inventors: **Yuhei Chiwata**, Kanagawa (JP); **Masahiro Ohba**, Kanagawa (JP); **Masataka Hasegawa**, Kanagawa (JP)

(73) Assignee: **FUJIFILM Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/727,156**

(22) Filed: **Dec. 26, 2012**

(65) **Prior Publication Data**

US 2013/0194367 A1 Aug. 1, 2013

(30) **Foreign Application Priority Data**

Jan. 31, 2012 (JP) 2012-019251

(51) **Int. Cl.**

F26B 17/28	(2006.01)
F26B 21/00	(2006.01)
B41F 23/04	(2006.01)
B41J 11/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F26B 21/004*** (2013.01); ***B41F 23/0443*** (2013.01); ***B41F 23/0466*** (2013.01); ***B41J 11/002*** (2013.01); ***B41J 11/0015*** (2013.01)

(58) **Field of Classification Search**

CPC B41J 11/002

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,293,196	B1	9/2001	DeMoore et al.
6,463,674	B1	10/2002	Meyers et al.
2005/0217523	A1	10/2005	Hachmann et al.
2011/0261102	A1	10/2011	Kurasawa et al.

FOREIGN PATENT DOCUMENTS

JP	H08-11299	A	1/1996
JP	H08-224871	A	9/1996
JP	2001-334647	A	12/2001
JP	2003-326682	A	11/2003
JP	2003-335447	A	11/2003
JP	2004-174887	A	6/2004
JP	2004-275998	A	10/2004
JP	2005-289059	A	10/2005
JP	2009-045861	A	3/2009
JP	2010-125819	A	6/2010
JP	2011-224932	A	11/2011
WO	2010/137299	A1	12/2010

OTHER PUBLICATIONS

Machine translation of JP 08-011299 A. (JP 08-011299 A was published on Jan. 16, 1996.).*

(Continued)

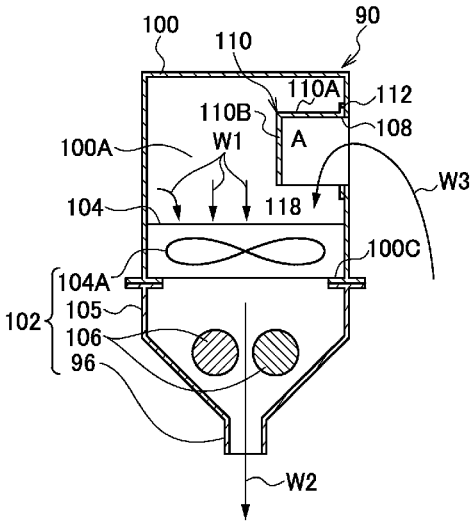
Primary Examiner — Justin Seo

(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

There is provided a drying device including: an airflow path extending in a direction intersecting with a conveyance path of a recording medium; an external air intake section that introduces external air into the airflow path; and a heating and blowing section provided to the airflow path that heats external air introduced into the airflow path and blows drying air onto a front face of the recording medium being conveyed on the conveyance path.

12 Claims, 11 Drawing Sheets



(56) **References Cited**

OTHER PUBLICATIONS

The extended European Search Report dated May 8, 2013, which corresponds to EP Application No. 12199460.2-1701 and is related to U.S. Appl. No. 13/727,156.

An Office Action; "Notice of Reasons for Rejection," issued by the Japanese Patent Office on Nov. 19, 2013, which corresponds to Japanese Patent Application No. 2012-019251 and is related to U.S. Appl. No. 13/727,156; with English language translation.

* cited by examiner

FIG.1

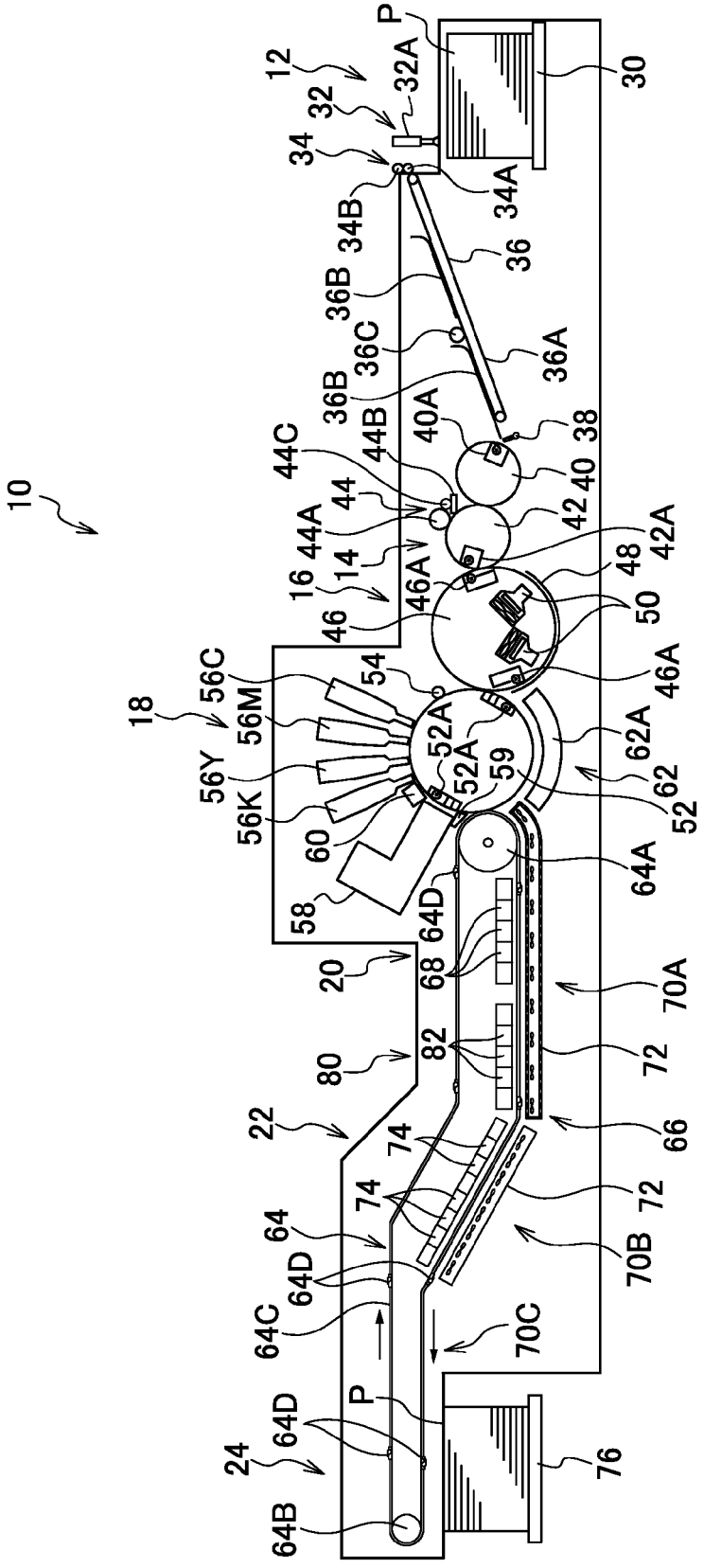

10
12
32
34
34B
36B
36C
36B
44B
44C
44
44A
16
14
46
46A
18
56C
56M
56Y
56K
60
58
54
52A
52A
59
62
62A
52
64A
64D
68
20
70A
72
80
82
22
74
74
72
66
64
64D
64C
70B
70C
P
64D
24
64B
76
P
32A
30
34A
36
36A
38
40A
40
42
42A
48
50
46A

FIG.2

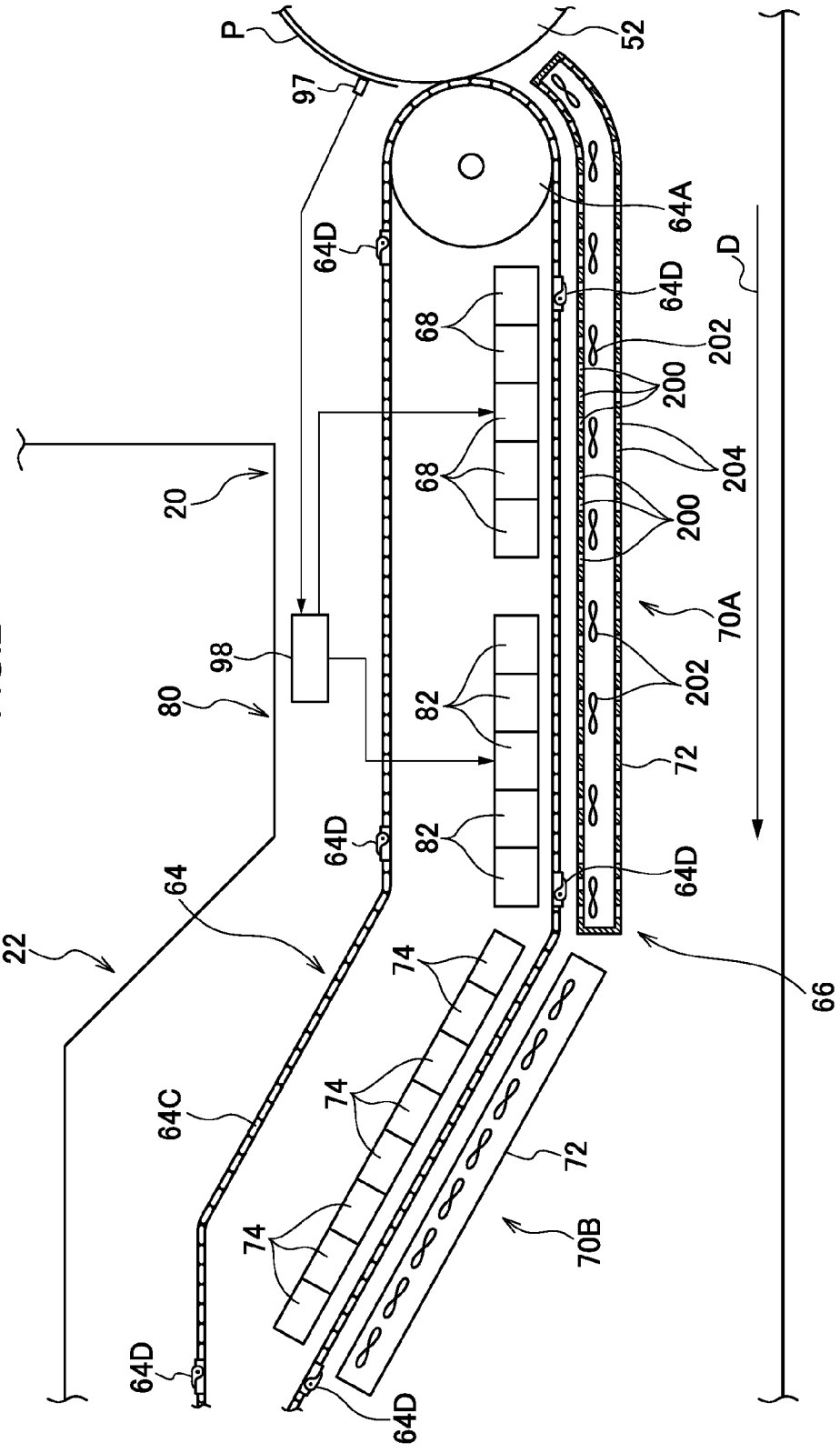
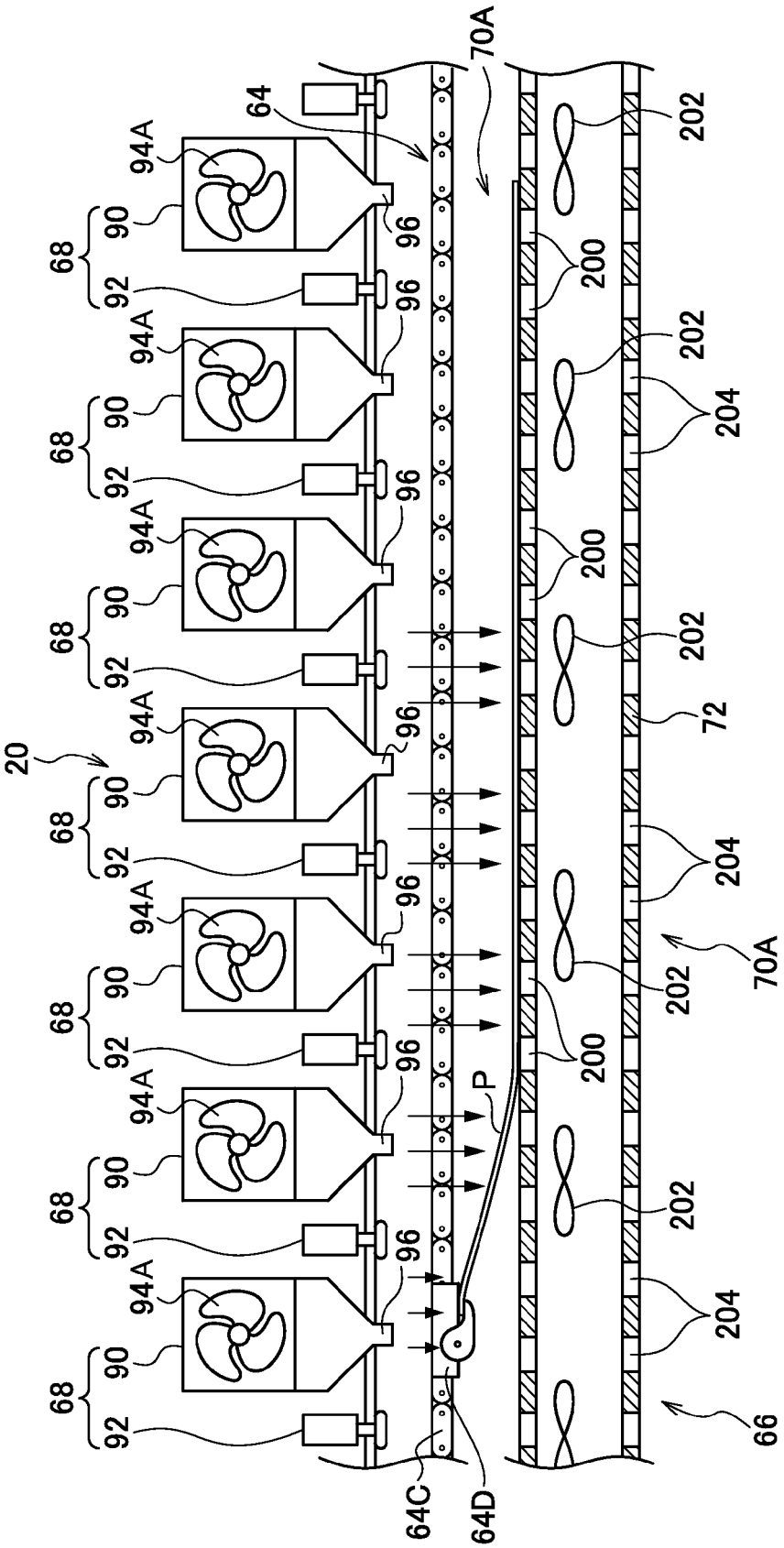

P
52
97
64A
64D
D
68
202
200
204
20
98
80
82
70A
72
22
64
74
66
64C
70B

FIG.3



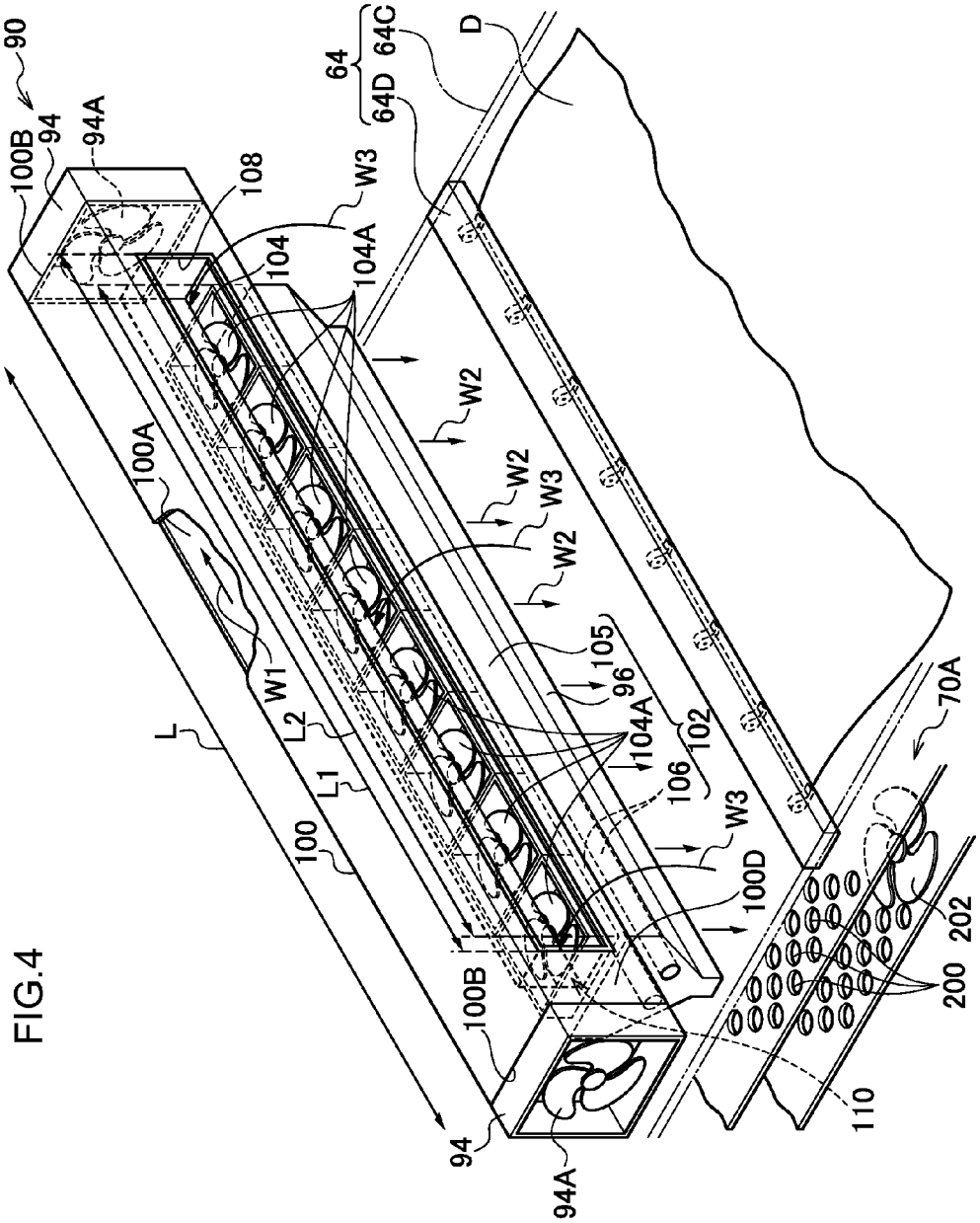

90
100B
94
94A
108
W3
64
64C
64D
D
104
104A
W2
100A
W1
L2
L1
L
100
105
96
102
106
70A
202
200
110
94
94A

FIG.4

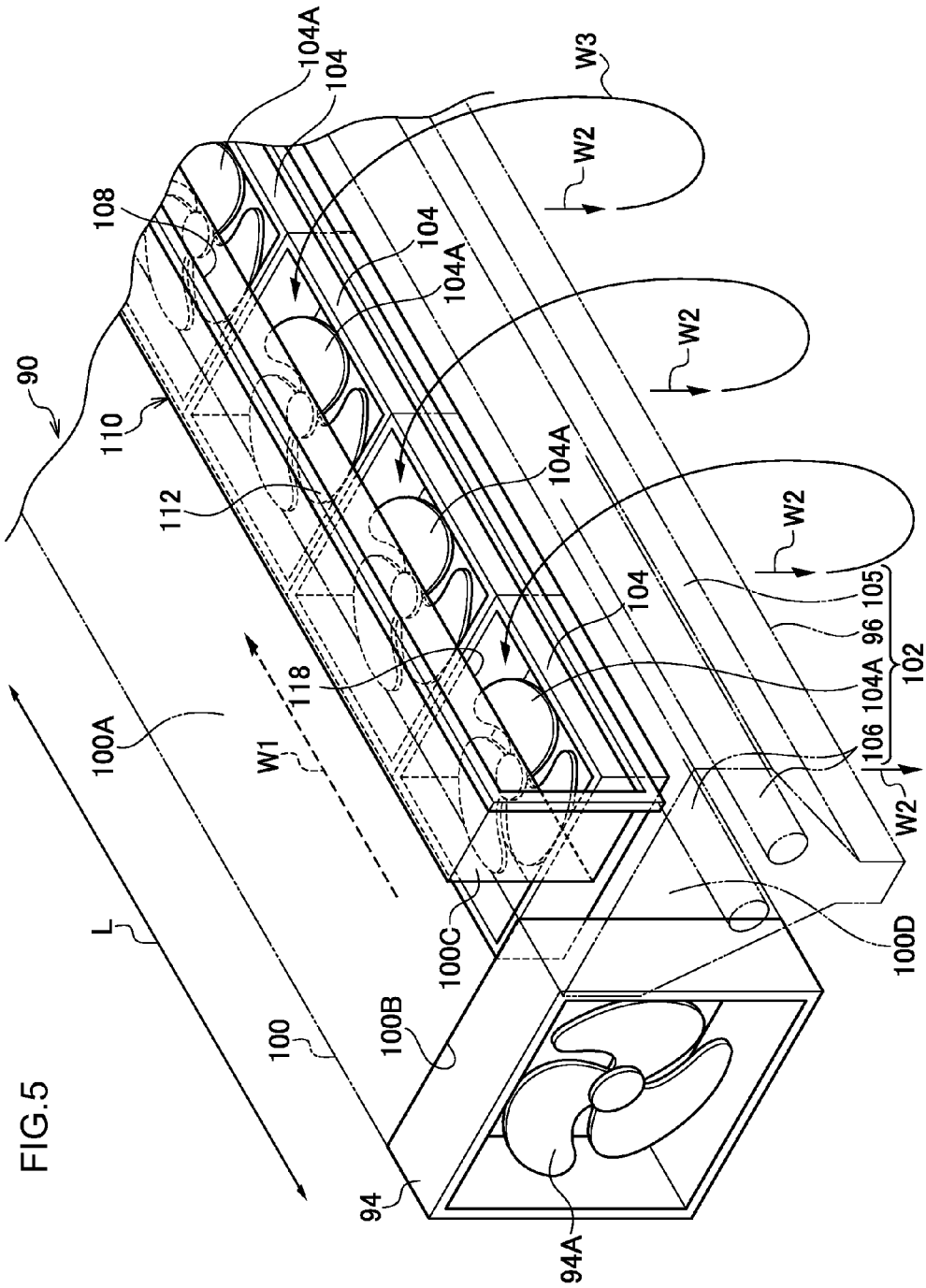
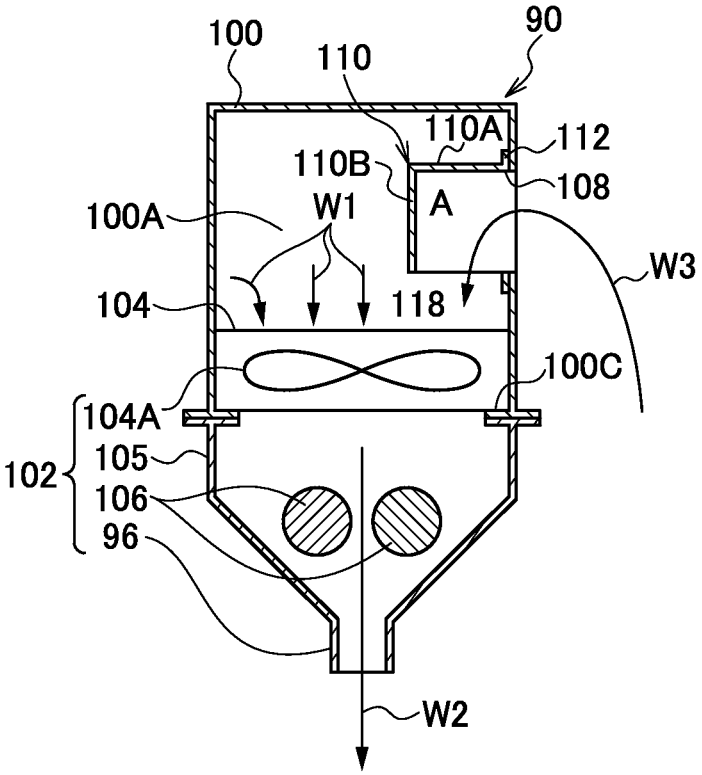

90
108
110
112
104A
104
W3
W2
W1
118
100A
L
100
100B
100C
100D
94
94A
96
105
102
106

FIG.5

FIG.6


100
110
90
110A
112
110B
108
A
100A
W1
W3
104
118
100C
104A
102
105
106
96
W2

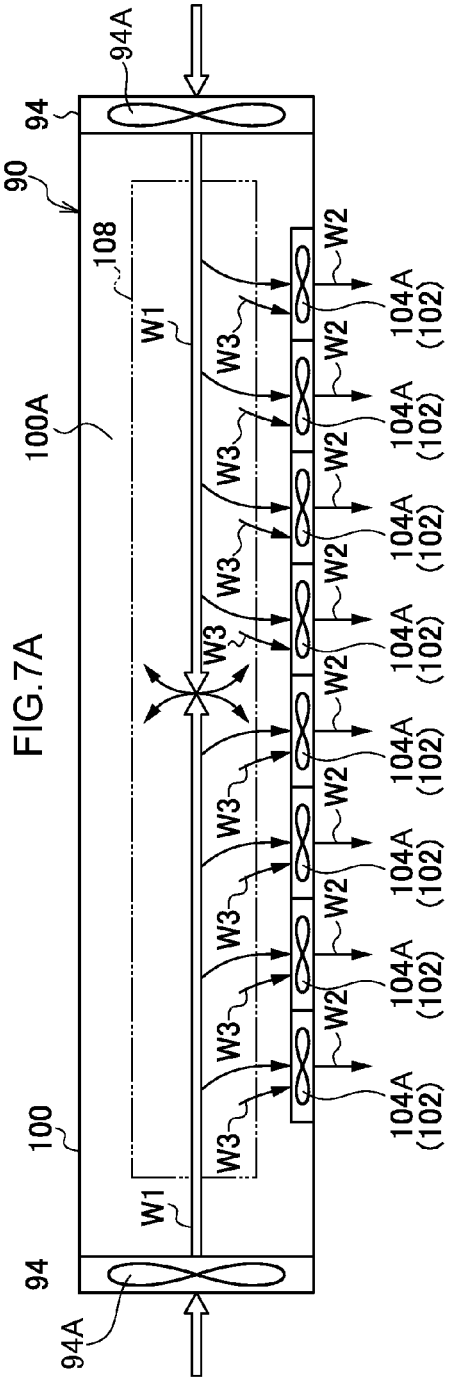

94A
94
90
108
100A
W1
W3
W2
104A
(102)
100
94
94A

FIG.7A

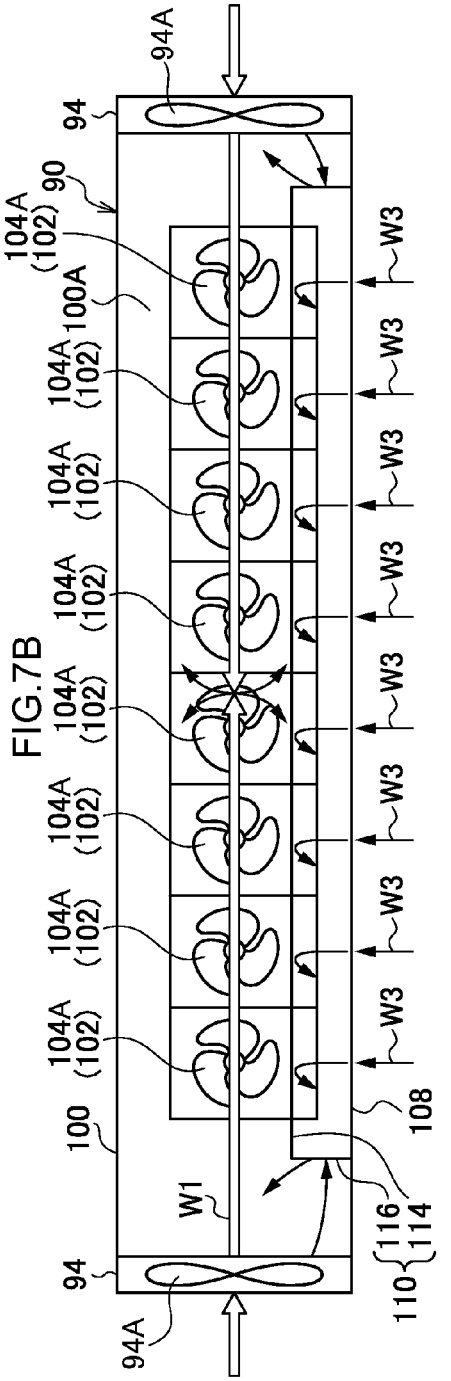

94A
94
90
104A
(102)
100A
W3
100
W1
108
116
114
110
94
94A

FIG.7B

FIG.8A

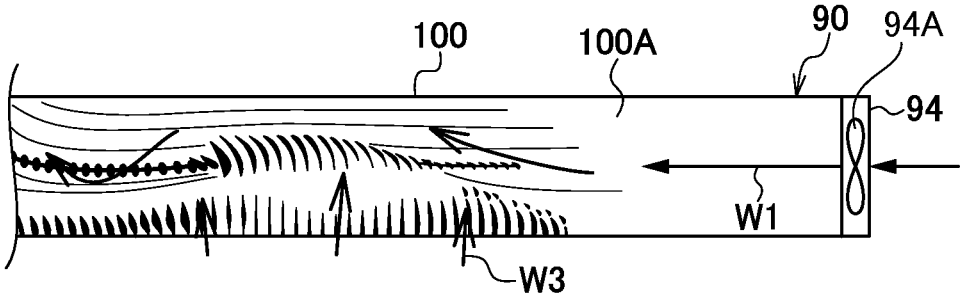
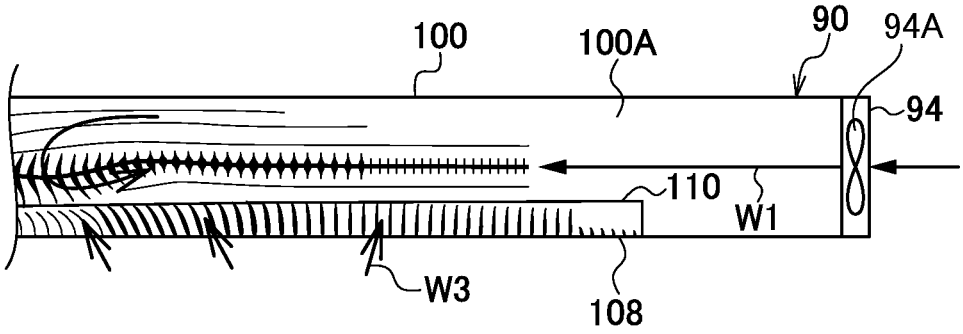


FIG.8B



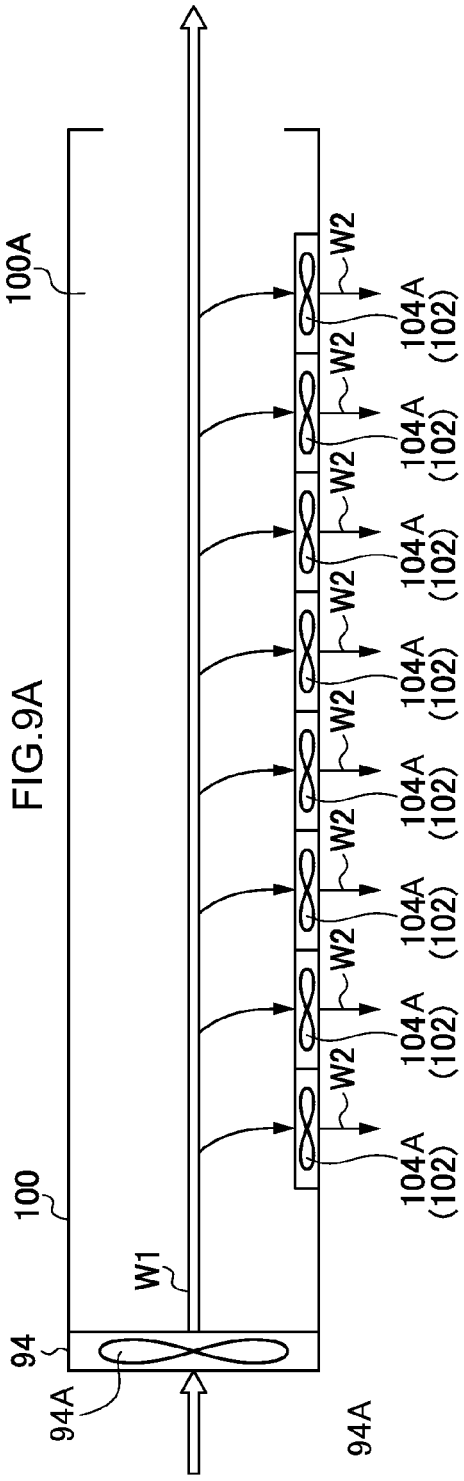

100A
100
94
94A
W1
W2
104A
(102)
94A

FIG.9A

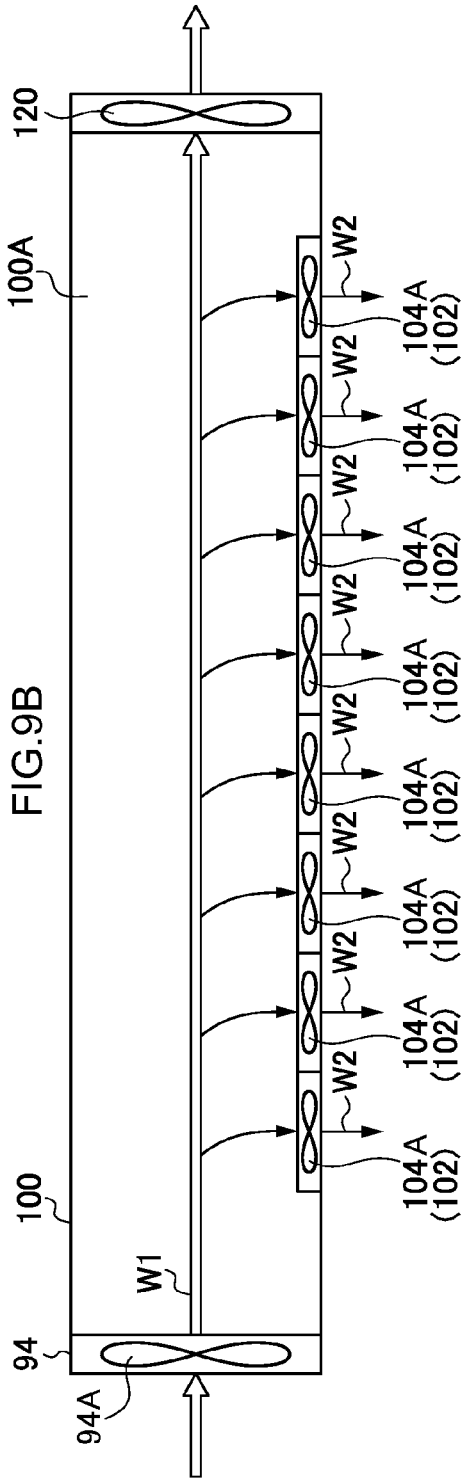

120
100A
100
94
94A
W1
W2
104A
(102)

FIG.9B

FIG.10A

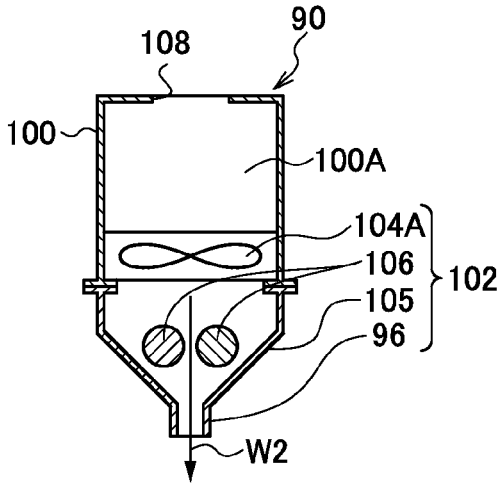


FIG.10B

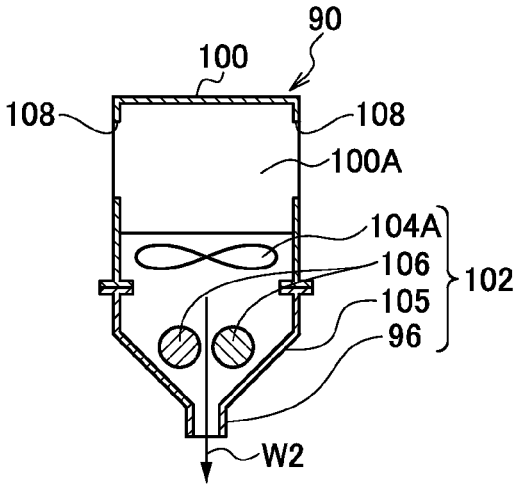


FIG.10C

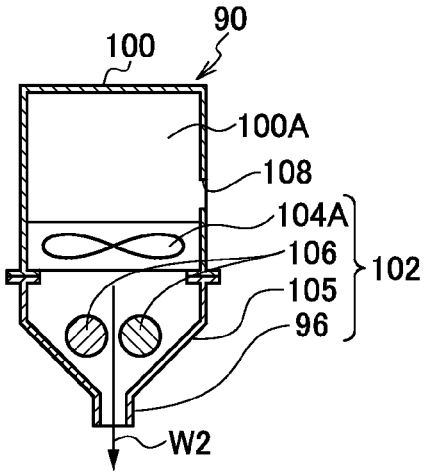


FIG.11A

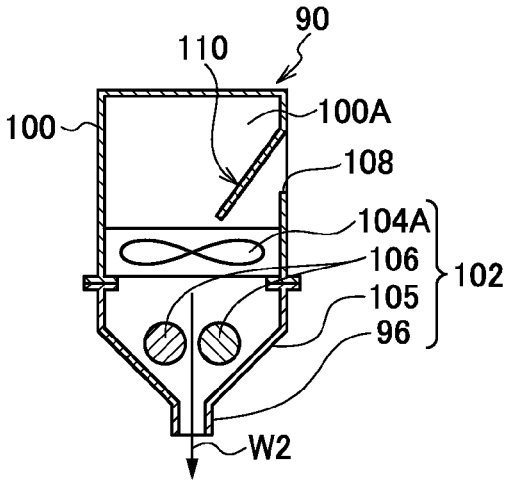


FIG.11B

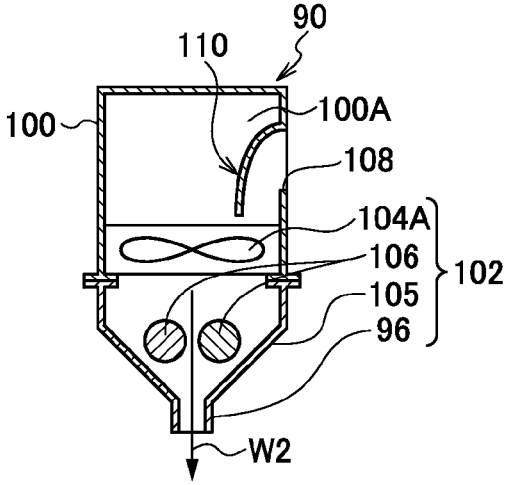
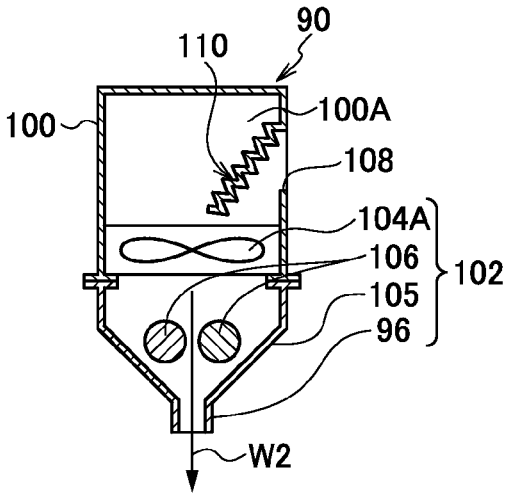


FIG.11C



DRYING DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2012-019251 filed on Jan. 31, 2012, the disclosure of which is incorporated by reference herein.

BACKGROUND

1. Technical Field

The present invention relates to a drying device and to an image forming apparatus.

2. Related Art

In image forming apparatuses, a known liquid droplet jetting recording type image forming apparatus includes liquid droplet jetting heads with multiple nozzles arranged in a row. Paper (a recording medium) is conveyed with respect to the liquid droplet jetting heads to form an image (including text) on the paper by jetting liquid droplets of for example ink from the nozzles towards the paper.

Processing performed after image forming in such liquid droplet jetting recording type image forming apparatuses reduces paper distortion (curling and cockling) caused by moisture in the liquid droplets by drying the paper onto which the liquid droplets have been jetted with a drying device.

Japanese Patent Application Laid-Open (JP-A) No. 2011-224932 discloses a configuration wherein external air is introduced into a drying device from the outside of an image forming apparatus, and the external air is blown as drying air onto a recording medium by a fan provided to the side of the recording medium that is being conveyed along a conveyance path.

JP-A No. 2009-45861 and JP-A No. 2010-125819 disclose a configuration wherein air inside an image forming apparatus is introduced into a drying device, and this air is blown as drying air onto the front face of a recording medium that is being conveyed on a conveyance path.

However, in the configuration of JP-A No. 2011-224932, the rate at which drying air is blown onto the recording medium is not uniform across the width direction of the recording medium since the drying air is blown from the side of the recording medium.

In the configurations of JP-A No. 2009-45861 and JP-A No. 2010-125819, the moisture content of the drying air increases since moist air inside the image forming apparatus is blown onto the recording medium as drying air.

SUMMARY

In consideration of the above circumstances, an object of the present invention is to provide a drying device and an image forming apparatus that can blow drying air onto a recording medium at a uniform rate across the width direction of the recording medium, whilst suppressing an increase in the moisture content of the drying air.

A first aspect of the present invention provides a drying device including:

an airflow path extending in a direction intersecting with a conveyance path of a recording medium;

an external air intake section that introduces external air into the airflow path; and

a heating and blowing section provided to the airflow path that heats external air introduced into the airflow path and blows drying air onto a front face of the recording medium being conveyed on the conveyance path.

According to the above configuration, external air introduced into the airflow path by the external air intake section is blown onto the front face of the recording medium as drying air by the heating and blowing section provided to the airflow path. The airflow rate can be made uniform across the width direction of the recording medium by blowing the drying air onto the front face of the recording medium.

Further, an increase in the moisture content of the drying air can be suppressed due to using external air for the drying air.

A second aspect of the present invention provides the drying device of the first aspect, wherein a circulation opening is formed along the length direction of the airflow path.

According to the above configuration, the energy efficiency of the heating and blowing section is improved since the drying air, which is blown out from the heating and blowing section, can be taken back into the airflow path through the circulation opening as recirculated air and recirculated.

A third aspect of the present invention provides the drying device of the second aspect, wherein the circulation opening comprises a partitioning plate that partitions recirculated air that is drying air recirculated to the circulation opening and external air that has been introduced into the airflow path.

According to the above configuration, the mixture ratio of fresh air and recirculated air can be made uniform along the length direction of the airflow path since circulated drying air in the airflow path, namely recirculated air, and external air introduced by the external air intake section flowing in the airflow path, namely fresh air, do not interfere with each other due to the partitioning plate.

A fourth aspect of the present invention provides the drying device of the third aspect, wherein:

the partitioning plate comprises a horizontal side extending horizontally towards the inside of the airflow path and a vertical side bending around from a leading edge of the horizontal side towards the heating and blowing section; and

both end portions of the partitioning plate are closed off with sealing plates.

According to the above configuration, recirculated air taken into the airflow path through the circulation opening hits the hood (vertical side) facing the circulation opening and changes direction towards the heating and blowing section side. Fresh air introduced into the airflow path from the external air intake section hits the sealing plates and is not introduced into the hood. Since the recirculated air circulating in the airflow path and the fresh air introduced by the external air intake section start to be mixed together in the vicinity of air fans, the mixture ratio of fresh air and recirculated air can be made more uniform across the length direction of the airflow path than if the sealing plates were not provided.

A fifth aspect of the present invention provides the drying device of any one of the second to fourth aspects, wherein the circulation opening is formed to the conveyance path upstream side of the airflow path.

Since drying of the recording medium takes place to the conveyance path downstream side of the airflow path, moisture content increases by the amount of moisture that has been evaporated from the recording medium.

In the configuration of the fifth aspect, the circulation opening is formed to the conveyance path upstream side of the airflow path. Therefore, drying air (recirculated air) taken in to the airflow path through the circulation opening accordingly has a lower moisture content than in cases in which the

circulation opening is formed to the conveyance path downstream side of the airflow path.

A sixth aspect of the present invention provides the drying device of any one of the second to fifth aspects, wherein:

the heating and blowing section comprises a plurality of axial fans provided along the airflow path length direction that take in external air that has been introduced into the airflow path and recirculated air that has been recirculated to the circulation opening and blows out the combined air; and

a heater that heats air blown from each of the axial fans to produce the drying air; and

the circulation opening is formed with a size such that recirculated air is taken in uniformly by each of the axial fans.

According to the above configuration, the moisture content of the drying air blown onto the recording medium from the heating and blowing section can be made more uniform across the width direction.

A seventh aspect of the present invention provides the drying device of any one of the first to sixth aspects, wherein the external air intake section is provided at both sides of the airflow path.

According to the above configuration, the amount of external air contained in the drying air blown from the heating and blowing section onto the recording medium can be made more uniform across the width direction than in cases where the external air intake section is provided at only one side of the airflow path, since the external air introduced by the external air intake section circulates and becomes uniform inside the airflow path.

An eighth aspect of the present invention provides the drying device of any one of the first to seventh aspects, wherein the heating and blowing section comprises a constricted opening that blows drying air onto the front face of the recording medium.

According to the above configuration, providing the constricted opening increases the airflow rate of drying air and raises the water vapor removal efficiency.

A ninth aspect of the present invention provides the drying device of any one of the first to eighth aspects, wherein a gripping member that grips the recording medium and conveys the recording medium on the conveyance path is attached to a moving member that travels in a circuit around the outside of the airflow path and the heating and blowing section.

According to the above configuration, external air can be introduced avoiding the moving member since the airflow path is disposed so as to protrude out in the width direction from between the circulating moving member.

A tenth aspect of the present invention provides an image forming apparatus including:

the drying device of any one of the first to ninth aspects; and

a liquid droplet jetting head that is provided to the conveyance path upstream side of the drying device and that jets liquid droplets onto the recording medium and renders an image.

According to the above configuration, the front face of the recording medium jetted with liquid droplets from the liquid droplet jetting head can be dried uniformly by the drying device across the width direction.

An eleventh aspect of the present invention provides the image forming apparatus of the tenth aspect, wherein:

the external air intake section comprises a fan; and

the image forming apparatus further comprises a controller that controls the airflow rate of the fan according to the liquid droplet amount jetted onto the recording medium.

According to the above configuration, the controller controls for example to decrease the airflow rate when the jetted liquid droplet amount is less than a given standard value, and to increase the airflow rate when the jetted liquid droplet amount is more than a given standard value. The recording medium can accordingly be dried reliably, and the energy efficiency of the fan(s) can also be raised.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a drawing of an overall configuration of an exemplary embodiment of an inkjet recording apparatus serving as an image forming apparatus according to the present invention;

FIG. **2** is an enlarged drawing of an ink drying section, a water application section and a UV irradiation section of an inkjet recording apparatus according to an exemplary embodiment of the present invention;

FIG. **3** is a drawing showing a state wherein water-based ultraviolet-curable ink is dried by drying air in the ink drying section whilst paper is being conveyed by a chain gripper;

FIG. **4** is a schematic drawing of a drying device;

FIG. **5** is an enlarged drawing showing an enlarged portion of the drying device in FIG. **4**, with a portion of the internal configuration of the drying device shown by solid lines;

FIG. **6** is a side-on cross-section of the drying device in FIG. **4**;

FIG. **7**A and FIG. **7**B are drawings to explain operation of a drying device according to an exemplary embodiment of the present invention;

FIG. **8**A is a drawing showing results of a simulation of how air flows in an airflow path with no partitioning plate present at a circulation opening;

FIG. **8**B shows results of a simulation of how air flows in an airflow path when a partitioning plate is present at a circulation opening;

FIG. **9**A is a drawing of a modified example of an external air intake fan;

FIG. **9**B is a drawing of a modified example of an external air intake fan;

FIG. **10**A is a drawing of a modified example of a circulation opening;

FIG. **10**B is a drawing of a modified example of a circulation opening;

FIG. **10**C is a drawing of a modified example of a circulation opening;

FIG. **11**A is a drawing of a modified example of a partitioning plate;

FIG. **11**B is a drawing of a modified example of a partitioning plate; and

FIG. **11**C is a drawing of a modified example of a partitioning plate.

DETAILED DESCRIPTION

Explanation follows regarding an exemplary embodiment of the present invention, with reference to the drawings.

Apparatus Configuration

FIG. **1** is a drawing of an overall configuration of an exemplary embodiment of an inkjet recording apparatus serving as an image forming apparatus of the present invention.

An inkjet recording apparatus **10** is an inkjet recording apparatus for recording an image on sheets of paper P (recording medium) by an inkjet method using water-based UV inks (inks that use an aqueous medium and are cured with ultraviolet (UV) light). The inkjet recording apparatus **10** is configured so as to principally include: a paper feed section **12** for

feeding the paper P; a process liquid application section **14** for applying a specific process liquid onto the front face (image recording face) of the paper P fed in from the paper feed section **12**; a process liquid drying section **16** for drying the paper P applied with the process liquid by the process liquid application section **14**; an image recording section **18** for recording an image with an inkjet method using water-based UV inks on the front face of the paper P that has been subjected to drying by the process liquid drying section **16**; an ink drying section **20** for drying the paper P recorded with an image by the image recording section **18**; a water application section **80** for applying water to the paper P that has been dried by the ink drying section **20**; a UV irradiation section **22** for performing UV irradiation (fixing processing) to the paper P applied with water by the water application section **80** so as to fix images onto the paper P; and a paper discharge section **24** for discharging the paper P that has been irradiated with UV by the UV irradiation section **22**.

Paper Feed Section

The paper feed section **12** feeds paper P stacked on a paper feed plate **30** to the process liquid application section **14** one sheet at a time. The paper feed section **12**, serving as an example of a paper feed section, is configured so as to principally include: the paper feed plate **30**; a sucker device **32**; a pair of paper feed rollers **34**; a feeder board **36**; a front stop **38**; and a paper feed drum **40**.

The paper P is placed on the paper feed plate **30** in a bundles of multiple stacked sheets. The paper feed plate **30** is equipped with a paper feed plate raising and lowering device, not shown in the drawings, that is capable of raising and lowering the paper feed plate **30**. The paper feed plate raising and lowering device is coordinated with increases and decreases in the paper P stacked on the paper feed plate **30**, with drive of the paper feed plate raising and lowering device controlled to raise and lower the paper feed plate **30** such that the paper P positioned uppermost in the batch is at a constant height.

The paper P serving as a recording medium is not particularly limited, and general purpose printing paper (paper principally formed from cellulose, such as what is referred to as premium grade paper, coated paper, or art paper) used in offset printing may be employed.

The sucker device **32** picks up the paper P stacked on the paper feed plate **30** one sheet at a time in sequence from the top, and feeds the paper P to the pair of paper feed rollers **34**. The sucker device **32** is equipped with suction feet **32**A provided so as to be capable of raising, lowering and swinging. The top face of the paper P is suction-attached and retained by the suction feet **32**A, such that the paper P is conveyed from the paper feed plate **30** to the pair of paper feed rollers **34**. Specifically the suction feet **32**A suction-attach and retain the top face of the leading edge side of the uppermost paper P, pick up the paper P, and insert the leading edge of the picked-up paper P between a pair of rollers **34**A, **34**B that configure the pair of paper feed rollers **34**.

The pair of paper feed rollers **34** are configured by a pair of top and bottom rollers **34**A, **34**B that are in press contact with each other. A first out of the pair of top and bottom rollers **34**A, **34**B is a drive roller (roller **34**A) and the other is a following roller (roller **34**B). The drive roller (roller **34**A) is rotationally driven by a motor, not shown in the drawings. The motor is driven in coordination with feeding the paper P. When the paper P is fed from the sucker device **32**, the motor rotates the drive roller (roller **34**A) at a coordinated timing. The paper P inserted between the pair of top and bottom rollers **34**A, **34**B is nipped by the rollers **34**A, **34**B and fed in the rotation direction of the rollers **34**A, **34**B (the direction in which the feeder board **36** is disposed).

The feeder board **36** is formed corresponding to the paper width, and receives the paper P fed out by the pair of paper feed rollers **34** and guides the paper P to the front stops **38**. The feeder board **36** is disposed so as to slope downwards, and the paper P placed on the conveyance face of the feeder board **36** is then guided by sliding along the conveyance face to the front stops **38**.

Plural tape feeders **36**A for conveying the paper P are disposed to the feeder board **36** at intervals in the width direction. The tape feeders **36**A are formed in an endless shape, and are driven so as to rotate by a motor, not shown in the drawings. The paper P placed on the conveyance face of the feeder board **36** is fed by the tape feeders **36**A and conveyed on the feeder board **36**.

Retainers **36**B and a roller **36**C are also disposed on the feeder board **36**. Plural of the retainers **36**B are disposed front-to-rear in lines along the paper P conveyance face (two in the present example). The retainers **36**B are configured by plate springs with a width corresponding to the paper width, and are disposed in press contact with the conveyance face. Unevenness in the paper P conveyed on the feeder board **36** by the tape feeders **36**A is corrected by passing under the retainers **36**B.

The roller **36**C is provided between the front and rear retainers **36**B. The roller **36**C is disposed in press contact with the conveyance face of the paper P. The paper P being conveyed between the front and rear retainers **36**B is conveyed with the top face of the paper P pressed down by the roller **36**C.

The front stop **38** corrects the orientation of the paper P. The front stop **38** is formed in a plate shape and is disposed orthogonally to the paper P conveyance direction. The front stop **38** is driven by a motor, not shown in the drawings, and is provided so as to be capable of swinging. The orientation of the paper P being conveyed on the feeder board **36** is corrected by the leading edge of the paper P contacting the front stop **38** (called skew prevention). The front stop **38** swings in coordination with paper feed to the paper feed drum **40**, and the orientation-corrected paper P is passed over to the paper feed drum **40**.

The paper feed drum **40** receives the paper P fed from the feeder board **36** through the front stops **38** and conveys the paper P towards the process liquid application section **14**. The paper feed drum **40** is formed in a circular cylindrical shape and is rotationally driven by a motor, not shown in the drawings. Grippers **40**A are also provided on the outer peripheral face of the paper feed drum **40** for gripping the leading edge of the paper P. The paper feed drum **40** thereby conveys the paper P towards the process liquid application section **14** by rotating with the leading edge portions of the paper P gripped by the grippers **40**A and the paper P wrapped onto the peripheral face of the paper feed drum **40**.

Process Liquid Application Section

The process liquid application section **14** applies a specific process liquid to the front face (image recording face) of the paper P. The process liquid application section **14** is configured so as to principally include: a process liquid application drum **42** for conveying the paper P, and a process liquid application unit **44** for applying a specific process liquid to the printing face of the paper P being conveyed by the process liquid application drum **42**.

The process liquid application drum **42** receives the paper P from the paper feed drum **40** of the paper feed section **12** and conveys the paper P towards the process liquid drying section **16**. The process liquid application drum **42** is formed in a

circular cylindrical shape and is rotationally driven by a motor, not shown in the drawings. Grippers **42**A are also provided on the outer peripheral face of the process liquid application drum **42** for gripping the leading edge of the paper P. The process liquid application drum **42** conveys the paper P towards the process liquid drying section **16** by rotating with the leading edge of the paper P gripped by the grippers **42**A and with the paper P wrapped around the peripheral face of the process liquid application drum **42** (one sheet of the paper P is conveyed with one rotation of the process liquid application drum **42**). The rotation of the process liquid application drum **42** and the paper feed drum **40** are controlled such that timings for passing over and receiving the paper P are coordinated with each other. Namely, the process liquid application drum **42** and the paper feed drum **40** are driven such that they have the same peripheral speed and are driven such that the positions of the grippers are coordinated with each other.

The process liquid application unit **44** uses a roller to coat the process liquid on the front face of the paper P being conveyed by the process liquid application drum **42**. The process liquid application unit **44** is configured so as to principally include: a coating roller **44**A for coating process liquid to the paper P; a process liquid tank **44**B in which process liquid is stored; and a pickup roller **44**C for picking up process liquid stored in the process liquid tank **44**B and feeding it to the coating roller **44**A.

Note than in the present example, configuration is made wherein the process liquid is coated by a roller, however, the method for applying the process liquid is not limited thereto. Configuration may also be adopted wherein the process liquid is applied employing inkjet heads, or applied as a spray.

Process Liquid Drying Section

The process liquid drying section **16** dries the paper P whose front face has been applied with process liquid. The process liquid drying section **16** is configured so as to principally include: a process liquid drying drum **46** for conveying the paper P; a paper conveyance guide **48**; and process liquid drying units **50** for drying the process liquid by blowing drying air onto the printing face of the paper P being conveyed by the process liquid drying drum **46**.

The process liquid drying drum **46** receives the paper P from the process liquid application drum **42** of the process liquid application section **14** and conveys the paper P towards the image recording section **18**. The process liquid drying drum **46** is configured with a circular cylindrical shaped frame body and is rotationally driven by a motor, not shown in the drawings. Grippers **46**A are provided on the outer peripheral face of the process liquid drying drum **46** for gripping the leading edge of the paper P. The process liquid drying drum **46** conveys the paper P towards the image recording section **18** by rotating with the leading edge of the paper P gripped by the grippers **46**A. Note that the process liquid drying drum **46** of the present example is provided with the grippers **46**A at two locations on the outer peripheral face, in a configuration capable of conveying two sheets of the paper P with a single rotation. Rotation of the process liquid drying drum **46** and the process liquid application drum **42** is controlled such that the timings for receiving and passing over the paper P are coordinated with each other. Namely, the process liquid drying drum **46** and the process liquid application drum **42** are driven such that they have the same peripheral speed and are driven such that the positions of the grippers are coordinated with each other.

The paper conveyance guide **48** is disposed along the paper P conveyance path to the side of the process liquid drying drum **46**, and guides conveyance of the paper P.

The process liquid drying units **50** are disposed inside the process liquid drying drum **46**, and dry by blowing drying air onto the front face of the paper P being conveyed by the process liquid drying drum **46**. The solvent component in the process liquid is accordingly driven off, forming an ink aggregation layer on the front face of the paper P. In the present example, two of the process liquid drying units **50** are provided inside the process liquid drying drum **46**, and are configured to blow drying air towards the front face of the paper P that is being conveyed by the process liquid drying drum **46**.

Image Recording Section

The image recording section **18** renders a color image on the printing face of the paper P by dotting liquid droplets of ink (water-based UV ink) of colors C, M, Y, K onto the printing face of the paper P. The image recording section **18** is configured so as to principally include: an image recording drum **52** for conveying the paper P; a paper press roller **54** for pressing the paper P conveyed by the image recording drum **52** so as to place the paper P in close contact with the peripheral face of the image recording drum **52**; inkjet heads **56**C, **56**M, **56**Y, **56**K serving as examples of liquid droplet jetting heads for jetting ink droplets of each color C, M, Y, K onto the paper P; an inline sensor **58** for reading an image recorded on the paper P; a mist filter **60** for trapping ink mist; and a drum cooling unit **62**.

The image recording drum **52** receives the paper P from the process liquid drying drum **46** of the process liquid drying section **16** and conveys the paper P towards the ink drying section **20**. The image recording drum **52** is formed in a circular cylindrical shape and is rotationally driven by a motor, not shown in the drawings. Grippers **52**A are provided on the outer peripheral face of the image recording drum **52** for gripping leading edges of the paper P. The image recording drum **52** conveys the paper P towards the ink drying section **20** by rotating with the leading edges of the paper P gripped by the grippers **52**A and the paper P wrapped around the peripheral face of the image recording drum **52**. The peripheral face of the image recording drum **52** is further provided with multiple suction holes (not shown in the drawings), formed in a specific pattern. The paper P wrapped around the peripheral face of the image recording drum **52** is conveyed whilst being suction-retained on the peripheral face of the image recording drum **52** by the suction of the suction holes. The paper P can accordingly be conveyed with a high degree of flatness.

Note that the suction of the suction holes only acts over a certain range, acting between a specific suction start position and a specific suction end position. The suction start position is set as the disposal position of the paper press roller **54**, and the suction end position is set at the downstream side of the disposal position of the inline sensor **58** (for example, set at the position where paper is passed to the ink drying section **20**). Namely, setting is made such that the paper P is suction-retained to the peripheral face of the image recording drum **52** at least at the disposal positions of the inkjet heads **56**C, **56**M, **56**Y, **56**K (image recording positions) and the disposal position of the inline sensor **58** (image reading position).

The mechanism for suction retention of the paper P to the peripheral face of the image recording drum **52** is not limited to the above negative pressure suction attachment method, and a method employing electrostatic attraction may also be adopted.

The image recording drum **52** of the present exemplary embodiment is disposed with the grippers **52**A at two locations on the outer peripheral face, in a configuration capable of conveying two sheets of the paper P with a single rotation. Rotation of the image recording drum **52** and the process

liquid drying drum **46** is controlled such that the timings for receiving and passing over the paper P are coordinated with each other. Namely, the image recording drum **52** and the process liquid drying drum **46** are driven such that they have the same peripheral speed, and are driven such that the positions of the grippers are coordinated with each other.

The paper press roller **54** is disposed in the vicinity of the sheet member receiving position of the image recording drum **52** (the position where the paper P is received from the process liquid drying drum **46**). The paper press roller **54** is configured from a rubber roller, and is disposed so as to be in press contact with the peripheral face of the image recording drum **52**. The paper P that has been passed over to the image recording drum **52** from the process liquid drying drum **46** accordingly makes close contact with the peripheral face of the image recording drum **52** due to being nipped on passing the paper press roller **54**.

The four inkjet heads **56**C, **56**M, **56**Y, **56**K are disposed at uniform intervals along the conveyance path of the paper P to the side of the image recording drum **52**. The inkjet heads **56**C, **56**M, **56**Y, **56**K are configured as line heads corresponding to the paper width, with a nozzle face disposed facing the peripheral face of the image recording drum **52**. Each of the inkjet heads **56**C, **56**M, **56**Y, **56**K record an image on the paper P being conveyed by the image recording drum **52** by jetting liquid ink droplets towards the image recording drum **52** from nozzle rows formed on the nozzle face.

Water-based UV ink is employed for the ink jetted from each of the inkjet heads **56**C, **56**M, **56**Y, **56**K. The water-based UV inks can be cured by irradiation with ultraviolet radiation (UV) after droplet impact.

The inline sensor **58** is disposed at the side of the image recording drum **52** on the downstream side of the last of the inkjet heads **56**K in the conveyance direction of the paper P. The inline sensor **58** reads the image recorded on the paper P by the inkjet heads **56**C, **56**M, **56**Y, **56**K. The inline sensor **58** is for example configured by a line scanner, and reads the image recorded by the inkjet heads **56**C, **56**M, **56**Y, **56**K on the paper P being conveyed by the image recording drum **52**.

A contact prevention plate **59** is disposed at the conveyance direction downstream side of the inline sensor **58** and adjacent to the inline sensor **58**. The contact prevention plate **59** prevents the paper P from making contact with the inline sensor **58** when lifting of the paper P occurs due for example to poor conveyance.

The mist filter **60** is disposed between the last of the inkjet heads **56**K and the inline sensor **58** so as to suck in air at the periphery of the image recording drum **52** and capture any ink mist. Ink mist is thereby suppressed from penetrating to the inline sensor **58** due to air being sucked in at the periphery of the image recording drum **52** and ink mist being captured, suppressing the occurrence of for example read errors.

The drum cooling unit **62** blows cool air onto the image recording drum **52**, cooling the image recording drum **52**. The drum cooling unit **62** is configured to principally include an air conditioner, not shown in the drawings, and a duct **62**A to blow cooled air supplied from the air conditioner onto the peripheral face of the image recording drum **52**. The duct **62**A blows cooled air towards the image recording drum **52** at a region outside a paper P conveyance region, and cools the image recording drum **52**. In the present example, the duct **62**A is configured to blow cooled air and cool the image recording drum **52** at a region that is substantially the bottom side half of the image recording drum **52**, since the paper P is conveyed substantially at the top side half of the circular arc shaped face of the image recording drum **52**. More specifically, the outlet of the duct **62**A is formed in a circular arc shape so as to cover substantially the lower side half of the image recording drum **52** and is configured to blow cooled air at a region that is substantially the lower side half of the image recording drum **52**.

The temperature to which the image recording drum **52** is cooled is set based on a relationship with the temperature of the inkjet heads **56**C, **56**M, **56**Y, **56**K (in particular, the temperature of the nozzle face), such that the image recording drum **52** is cooled to a lower temperature than the temperature of the inkjet heads **56**C, **56**M, **56**Y, **56**K. Condensation can accordingly be prevented from occurring on the inkjet heads **56**C, **56**M, **56**Y, **56**K. Namely, by lowering the temperature of the image recording drum **52** to below that of the inkjet heads **56**C, **56**M, **56**Y, **56**K, any condensation can be induced to occur on the image recording drum side, and condensation can be prevented from occurring on the inkjet heads **56**C, **56**M, **56**Y, **56**K (in particular, condensation occurring on the nozzle face).

Ink Drying Section

The ink drying section **20** dries the paper P after image recording, and drives off the liquid component remaining on the recording face of the paper P. The ink drying section **20** is configured to principally include: a chain gripper **64** for conveying the paper P on which an image has been recorded; a back tension application mechanism **66** serving as an example of a back tension application section that applies back tension to the paper P being conveyed by the chain gripper **64**; and ink drying units **68** serving as an example of drying units for drying the paper P being conveyed by the chain gripper **64**.

The chain gripper **64** is a common paper conveyance mechanism employed in the ink drying section **20**, the water application section **80**, the UV irradiation section **22**, and the paper discharge section **24**. The chain gripper **64** receives the paper P passed from the image recording section **18** and conveys it as far as the paper discharge section **24**.

The chain gripper **64** is configured to principally include: first sprockets **64**A disposed in the vicinity of the image recording drum **52**; second sprockets **64**B provided to the paper discharge section **24**; endless chains **64**C entrained around the first sprockets **64**A and the second sprockets **64**B; plural chain guides (not shown in the drawings) for guiding travel of the chains **64**C; and plural grippers **64**D attached to the chain **64**C at uniform intervals. The first sprockets **64**A, the second sprockets **64**B, the chains **64**C and the chain guides are respectively configured in pairs, and are disposed on both width direction sides of the paper P. The grippers **64**D are disposed spanning between the pair of chains **64**C.

The first sprockets **64**A are disposed in the vicinity of the image recording drum **52** so as to be capable of receiving the paper P passed over from the image recording drum **52** with the grippers **64**D. The first sprockets **64**A are rotatably supported by shaft bearings, not shown in the drawings, and are coupled to a motor, not shown in the drawings. The chains **64**C entrained around the first sprockets **64**A and the second sprockets **64**B are run by driving the motor.

The second sprockets **64**B are provided at the paper discharge section **24** so as to be capable of collecting the paper P received from the image recording drum **52** at the paper discharge section **24**. Namely, the disposal position of the second sprockets **64**B configures the terminal of the paper P conveyance path along the chain gripper **64**. The second sprockets **64**B are provided rotatably supported by shaft bearings, not shown in the drawings.

The chains **64**C are formed with an endless shape, and are entrained around the first sprockets **64**A and the second sprockets **64**B.

The chain guides are disposed at specific positions, and guide such that the chains **64**C travel along a specific path (=guide such that the paper P is conveyed to travel along a specific conveyance path). In the inkjet recording apparatus **10** of the present example, the second sprockets **64**B are provided at a position higher than the first sprockets **64**A. The chains **64**C accordingly form a traveling path that is inclined en route. More specifically, the traveling path is configured from a first horizontal conveyance path **70**A, an inclined conveyance path **70**B, and a second horizontal conveyance path **70**C.

The first horizontal conveyance path **70**A is set at a similar height to the first sprockets **64**A, and the chains **64**C entrained around the first sprockets **64**A are set to travel horizontally. The second horizontal conveyance path **70**C is set at a similar height to the second sprockets **64**B, and the chains **64**C entrained around the second sprockets **64**B are set to travel horizontally. The inclined conveyance path **70**B is set between the first horizontal conveyance path **70**A and the second horizontal conveyance path **70**C and is set so as to connect the first horizontal conveyance path **70**A and the second horizontal conveyance path **70**C.

The chain guides are disposed so as to form the first horizontal conveyance path **70**A, the inclined conveyance path **70**B, and the second horizontal conveyance path **70**C. More specifically, the chain guides are disposed at least at a junction point of the first horizontal conveyance path **70**A and the inclined conveyance path **70**B, and a junction point of the inclined conveyance path **70**B and the second horizontal conveyance path **70**C.

Plural grippers **64**D are attached to the chains **64**C at uniform intervals. The attachment intervals of the grippers **64**D are set so as to match the intervals between receiving the paper P from the image recording drum **52**. Namely, the attachment intervals of the grippers **64**D are set so as to match the intervals between receiving the paper P from the image recording drum **52**, such that the paper P passed over in sequence from the image recording drum **52** can be received from the image recording drum **52** at a coordinated timing.

The chain gripper **64** is configured as described above. As explained above, the chains **64**C travel when the motor (not shown in the drawings) connected to the first sprockets **64**A is driven. The chains **64**C travel at the same speed as the peripheral speed of the image recording drum **52**. Timing is coordinated such that the paper P passed over from the image recording drum **52** can be received by each of the grippers **64**D.

The back tension application mechanism **66** applies back tension to the paper P being conveyed whilst a leading edge is gripped by the chain gripper **64**. As illustrated in FIG. **2** and FIG. **3**, the back tension application mechanism **66** is principally provided with a guide plate **72**, and plural suction fans **202** that suck in air through multiple suction holes **200** formed in the upper face of the guide plate **72**. Multiple holes **204** are provided in the bottom face of the guide plate **72** for expelling the sucked-in air.

The guide plate **72** is configured from a hollow box plate with a width corresponding to the paper width. The guide plate **72** is disposed along the conveyance path of the paper P alongside the chain gripper **64**, i.e., the chain travel path. More specifically, the guide plate **72** is disposed along the chains **64**C that travel on the first horizontal conveyance path **70**A and the inclined conveyance path **70**B, disposed at a specific separation distance from the chains **64**C. The back face of the paper P (the face on the side not recorded with an image) being conveyed by the chain gripper **64** is conveyed in sliding contact across the upper face of the guide plate **72** (the face that faces the chains **64**C: the sliding contact face).

The sliding contact face (upper face) of the guide plate **72** is formed with multiple of the suction holes **200** in a specific pattern. The guide plate **72** is formed from a hollow box plate, as mentioned above. The suction fans **202** create suction in the hollow portion (inside) of the guide plate **72**. Air is accordingly sucked through the suction holes **200** formed in the sliding contact face.

The back face of the paper P being conveyed by the chain gripper **64** is sucked against the suction holes **200** due to air being sucked through the suction holes **200** of the guide plate **72**. Back tension is accordingly applied to the paper P being conveyed by the chain gripper **64**.

As described above, back tension is applied to the paper P while being conveyed along the first horizontal conveyance path **70**A and the inclined conveyance path **70**B since the guide plates **72** are disposed respectively along the chains **64**C that travel along the first horizontal conveyance path **70**A and the inclined conveyance path **70**B.

As illustrated in FIG. **1**, the ink drying units **68** are disposed to the inside of the chain gripper **64** (specifically at the front half side of the location that configures the first horizontal conveyance path **70**A). The ink drying units **68** dry the paper P being conveyed along the first horizontal conveyance path **70**A. The ink drying units **68** dry the paper P by blowing drying air onto the recording face of the paper P being conveyed along the first horizontal conveyance path **70**A. Plural the ink drying units **68** are disposed along the first horizontal conveyance path **70**A. The number of the ink drying units **68** provided is set according to such factors as the processing capacity of the ink drying units **68** and the conveyance speed of the paper P, i.e., printing speed. Namely, setting is made such that the paper P received from the image recording section **18** can be dried whilst being conveyed on the first horizontal conveyance path **70**A. The length of the first horizontal conveyance path **70**A is accordingly also set in consideration of the capacity of the ink drying units **68**. Note that the configuration of the ink drying units **68** is described in detail later.

Water Application Section

The water application section **80** is provided to the inside of the chain gripper **64** (specifically, at the back half side of the location that configures the first horizontal conveyance path **70**A), and applies water to the paper P being conveyed on the first horizontal conveyance path **70**A after it has passed through the ink drying section **20**. The water application section **80** is principally configured by the chain gripper **64** that conveys the dried paper P, the back tension application mechanism **66** that applies back tension to the paper P being conveyed by the chain gripper **64**, and water application units **82** that apply water to the paper P that is being conveyed by the chain gripper **64** and serve as an example of a water application section. The water application units **82** apply water to the paper P by for example spraying fine droplets of water onto the paper P. The amount of moisture in the paper P is accordingly regulated. Plural of the water application units **82** are disposed along the first horizontal conveyance path **70**A. The number of water application units **82** provided is set according to for example the capacity of the water application units **82** and the conveyance speed of the paper P, i.e., printing speed. Namely, setting is made such that after the paper P has been dried by the ink drying units **68**, the paper P can be applied with a specific amount of moisture whilst being conveyed on the first horizontal conveyance path **70**A.

UV Irradiation Section

The UV irradiation section **22** irradiates ultraviolet radiation (UV) onto images recorded using the water-based UV ink, so as to fix the images. The UV irradiation section **22** is configured so as to principally include the chain gripper **64** to convey the paper P, the back tension application mechanism **66** to apply back tension to the paper P being conveyed by the chain gripper **64**, and UV irradiation units **74** serving as examples of a fixing unit that irradiates ultraviolet radiation onto the paper P being conveyed by the chain gripper **64**.

As described above, the chain gripper **64** and back tension application mechanism **66** here are also commonly employed over the ink drying section **20**, the water application section **80** and the paper discharge section **24**.

The UV irradiation units **74** are disposed to the inside of the chain gripper **64** (specifically at a location that configures the inclined conveyance path **70**B), and irradiates ultraviolet radiation onto the recording face of the paper P being conveyed on the inclined conveyance path **70**B. The UV irradiation units **74** are provided with an ultraviolet lamp (UV lamp), and plural of the UV irradiation units **74** are disposed along the inclined conveyance path **70**B. The UV irradiation units **74** irradiate ultraviolet radiation onto the recording face of the paper P being conveyed on the inclined conveyance path **70**B. The number of the UV irradiation units **74** provided is set according to for example to the conveyance speed of the paper P, i.e., printing speed. Namely, setting is made such that images can be fixed by ultraviolet radiation irradiation whilst the paper P is being conveyed on the inclined conveyance path **70**B. The length of the inclined conveyance path **70**B is accordingly also set in consideration of for example the conveyance speed of the paper P.

Paper Discharge Section

The paper discharge section **24** collects the paper P that has been subjected to a cycle of image recording processing. The paper discharge section **24** is configured so as to principally include the chain gripper **64** for conveying the UV irradiated paper P, and a paper discharge plate **76** for stacking and collecting the paper P.

As described above, the chain gripper **64** here is also commonly employed over the ink drying section **20** and the UV irradiation section **22**. The chain gripper **64** releases the paper P over the paper discharge plate **76**, stacking the paper P on the paper discharge plate **76**.

The paper discharge plate **76** stacks and collects the paper P released from the chain gripper **64**. The paper discharge plate **76** is provided with paper stops (for example a front paper stop, a rear paper stop, and side paper stops) (not shown in the drawings) in order to stack the paper P neatly.

The paper discharge plate **76** is equipped with a paper discharge plate raising and lowering device, not shown in the drawings, that is capable of raising and lowering the paper discharge plate **76**. The paper discharge raising and lowering device is coupled to increases and decreases in the amount of paper stacked in the paper discharge plate **76**, with drive controlled so that the paper discharge plate **76** is raised and lowered such that the uppermost sheet of paper P is positioned at a constant height.

Detailed Description of the Image Recording Section, the Ink Drying Section, the Water Application Section and the UV Irradiation Section

More detailed explanation follows regarding the image recording section **18**, the ink drying section **20**, the water application section **80** and the UV irradiation section **22** that are relevant portions of the inkjet recording apparatus **10** of the present exemplary embodiment. FIG. **2** is an enlarged drawing of the ink drying section **20**, the water application section **80** and the UV irradiation section **22** of the inkjet recording apparatus **10** of an exemplary embodiment of the present invention. FIG. **3** is a drawing showing a state in which water-based ultraviolet-curable ink is being dried by drying air in the ink drying section **20** whilst the paper is being conveyed by a chain gripper.

As illustrated in FIG. **1**, each of the inkjet heads **56**C, **56**M, **56**Y, **56**K jet droplets of ink (water-based UV ink) of the corresponding color towards the recording face of the paper P that is being retained in tight contact on the image recording drum **52** in the image recording section **18**. The ink lands on the process liquid that has been pre-applied to the recording face in the process liquid application section **14**, and the coloring matter (pigment) dispersed in the ink aggregates, forming an aggregate body of coloring material. The coloring material is thereby prevented from running on the paper P, and an image is formed on the recording face of the paper P.

As illustrated in FIG. **2** and FIG. **3**, the paper P being conveyed by the chain gripper **64** is dried by the ink drying units **68** in the ink drying section **20**. Namely, the ink drying section **20** is a mechanism that dries moisture included in the solvent that has been separated in the coloring material aggregation process, and is provided with plural ink drying units **68** each arranged with an IR heater **92** at a position facing the paper P being conveyed by the chain gripper **64**, and a drying device **90**, described later.

The chain gripper **64** grips a leading edge of each sheet of paper P with the grippers **64**D and conveys the paper P along the flat-faced guide plate **72**, and drying is performed by the ink drying units **68** disposed to the inside of the chain gripper **64**. When this is being performed the paper P is being conveyed with back tension applied by the back tension application mechanism **66** so that creases do not occur, and being dried by drying air from the ink drying units **68**. Curling and cockling of the paper P is accordingly suppressed.

As illustrated in FIG. **3**, the drying devices **90**, described in detail later, are each provided with external air intake fans **94**A for introducing external air inside the drying device **90** from outside the of the inkjet recording apparatus **10**, and a drying air blowing nozzle **96**. The drying air blowing nozzle **96** is configured to increase the rate of airflow of drying air containing external air introduced from outside into the drying device **90** controlled to a specific temperature, and to blow the drying air onto the recording face of the paper P. The IR heaters **92** are respectively controlled to a specific temperature, and warm the inside of the first horizontal conveyance path **70**A. The drying air blowing nozzles **96** and the IR heaters **92** perform drying by evaporating moisture contained in the recording face of the paper P.

As illustrated in FIG. **2**, an ink quantity detection sensor **97** that detects an amount of ink jetted onto the recording face of the conveyed paper P is provided facing the peripheral face of the image recording drum **52** at a position further to the (conveyance direction D) downstream side of the image recording drum **52** than the inkjet heads **56**C, **56**M, **56**Y, **56**K.

A signal detected by the ink quantity detection sensor **97** is input to a controller **98**. The controller **98** includes a CPU and memory and the like, and controls the airflow rate of the external air intake fan **94**A according to the amount of drying the paper P requires, namely according to the input signal (ink amount). More specifically, as for example illustrated in Table 1 below, if the input ink amount is lower than a given standard value (a normal amount), the controller **98** reduces the airflow rate by reducing the rotation speed of the external air intake fans **94**A. If the input ink amount is significantly lower than the given standard value (the normal amount), the controller **98** greatly reduces the airflow rate by greatly reduc-

ing the rotation speed of the external air intake fans **94**A. If the input ink amount is the given standard value (the normal amount), the controller **98** performs control for a normal airflow rate by setting the rotation speed of the external air intake fans **94**A to a standard value rotation speed. If the input ink amount is higher than the given standard value (the normal amount), the controller **98** performs control to increase the airflow rate by increasing the rotation speed of the external air intake fans **94**A.

TABLE 1

Ink Amount	Rotation speed (Airflow Rate)
High	High
Normal (Standard)	Normal (Standard)
Low	Low
Very low	Very low

After the paper P has been dried in the ink drying section **20**, water is applied to the paper P being conveyed by the chain gripper **64** by the water application units **82** in the water application section **80**. The water application units **82** apply water such that the amount of moisture included in the paper P lies within a desired range. The amount of moisture in the paper P is accordingly regulated such that the paper P is not over dried by the ink drying section **20**. Water is applied to the paper P by the water application units **82** whilst back tension is being applied to the paper P by the back tension application mechanism **66**.

In the present exemplary embodiment, configuration is made such that water is applied from above the paper P downwards onto the recording face side of the paper P by the water application units **82**. Water can be applied more evenly to the paper P due to the water being applied from above the paper P downwards by the water application units **82**. Note that the "water" applied to the paper P by the water application units **82** encompasses liquids having water as a main component. For example, this includes cases in which a liquid applied to the paper P by the water application units **82** is water with additives such as preservatives.

The image is fixed in the UV irradiation section **22** by irradiating ultraviolet radiation (UV) from the UV irradiation units **74** onto images recorded on the recording face of the paper P employing water-based UV inks. The UV irradiation units **74** may employ plural ultraviolet radiation sources. Reducing the irradiation intensity of each of the ultraviolet radiation sources allows curing conditions to be achieved by irradiation duration and for a reduction in cost and amount of heat generated by the UV irradiation units **74** to be achieved.

The ultraviolet radiation sources employed in the UV irradiation units **74** are not particularly limited, and examples thereof that may be applied include metal halide lamps, mercury lamps, excimer lasers, ultraviolet lasers, black lights, cold-cathode tubes, LEDs, and laser diodes. Metal halide lamp tubes, mercury lamp tubes or black lights, for example, are preferably employed.

Detailed Description of the Drying Devices

Explanation follows regarding the drying devices **90** of the present exemplary embodiment. FIG. **4** is a schematic drawing of one of the drying devices **90**. FIG. **5** is an enlarged drawing of part of the drying device **90** illustrated in FIG. **4**, showing a portion of the internal configuration of the drying device **90** in solid lines. FIG. **6** is a cross-section of the drying device **90** illustrated in FIG. **4**, viewed from the side.

Each of the drying devices **90** includes a duct **100**, the external air intake fans **94**A, and heating and blowing sections **102**. Each heating and blowing section **102** is provided with a fan **104**A, a heating box **105**, infrared heaters **106** and the drying air blowing nozzle **96**. Each configuration element is explained below.

The duct **100** faces towards the first horizontal conveyance path **70**A, extends in a direction orthogonal to the first horizontal conveyance path **70**A, and is disposed so as to protrude out widthwise between the chains **64**C that circulate around the outside of the drying device **90**. The duct **100** is a tube body with a rectangular cross-section with the inside configuring an airflow path **100**A.

Both end portions **100**B of the duct **100** are connected to fan boxes **94** respectively provided with the axial flow type external air intake fans **94**A. The fan boxes **94** are attached to air intake openings (not shown in the drawings) formed in the housing of the inkjet recording apparatus **10**. Accordingly, fresh air from outside the inkjet recording apparatus **10** is forced into the airflow path **100**A when the external air intake fans **94**A are driven. Currents of external air are accordingly created inside the airflow path **100**A, in directions orthogonal to the first horizontal conveyance path **70**A.

Note that "external air" generally has a lower temperature and lower moisture content than air inside the inkjet recording apparatus **10** (internal air), for example having a temperature between 20° C. and 30° C. and a moisture content of 60% or less.

The bottom face of the duct **100** is open (opening **100**C in FIG. **6**), and the plural fans **104**A that are rotatably supported in frames **104** are disposed along the length direction L of the airflow path **100**A. The heating box **105** of funnel-shaped cross-section is attached below the fans **104**A. A pair of the infrared heaters **106** is disposed extending in the length direction L of the airflow path **100**A inside the heating box **105**. A bottom opening of the heating box **105** is constricted and extends in the length direction L, forming the drying air blowing nozzle **96**.

Accordingly, external air in the airflow path **100**A that is taken into the heating box **105** by the plural fans **104**A is heated by the infrared heaters **106** and is blown out of the drying air blowing nozzle **96** as drying air W**2**.

A side wall **100**D on the first horizontal conveyance path **70**A upstream side of the duct **100** is formed with a rectangular circulation opening **108** extending along the length direction L of the duct **100**.

As illustrated in FIG. **4**, a length L**1** of the circulation opening **108** is formed longer than a length L**2** of the row of frames **104** housing the fans **104**A, in a configuration such that recirculated air W**3** is drawn evenly through the circulation opening **108** by the fans **104**A. As illustrated in FIG. **6**, a hood **110**, serving as a partitioning plate, and provided with a horizontal side **110**A extending horizontally from an upper opening edge of the circulation opening **108** towards the inside of the airflow path **100**A and a vertical side **110**B bending around from the leading edge of the horizontal side **110**A towards the fans **104**A, is attached to the circulation opening **108** through a flange **112**.

The hood **110** is provided extending along the length direction L, and a space inside the hood **110**, namely a space A enclosed by the circulation opening **108** and the hood **110** as illustrated in FIG. **6**, is closed off by sealing plates **110**C (see FIG. **5**) at both end portions of the hood **110**, such that external air introduced by the external air intake fans **94**A does not cut across along the length direction L inside of the hood **110**.

Operation

Explanation follows regarding operation and advantageous effects of the drying device **90** and the inkjet recording apparatus **10** according to an exemplary embodiment of the present invention. FIG. **7**A and FIG. **7**B are drawings explain-

ing the operation of the drying device **90** according to an exemplary embodiment of the present invention. Note that certain elements including the drying air blowing nozzle **96** and infrared heaters **106** of the drying device **90** are omitted from illustration in FIG. **7**A and FIG. **7**B.

As illustrated in FIG. **7**A and FIG. **7**B, in the drying device **90** of the present exemplary embodiment, external air (fresh air W**1**) introduced into the airflow path **100**A by the external air intake fans **94**A forms a current of fresh air W**1** in the airflow path **100**A. Due to the fans **104**A and the infrared heaters **106** provided along the airflow path **100**A, the current of fresh air W**1** is blown onto the recording face of the conveyed paper P as drying air W**2**. An even airflow rate can be achieved across the paper P width direction due to blowing the drying air W**2** onto the recording face of the paper P with the plural fans **104**A disposed in the length direction L.

Further, an increase in the moisture content of the drying air W**2** can be suppressed due to employing the fresh air W**1** in the drying air W**2**.

In the drying device **90** according to the present exemplary embodiment, the amount of electricity used by the infrared heaters **106** is cut and energy efficiency improved, since some of the drying air W**2** blown out towards the paper recording face is taken back into the airflow path **100**A through the circulation opening **108** and recirculated as recirculated air W**3**.

Note that since the drying air W**2** can absorb moisture in the first horizontal conveyance path **70**A before being taken back into the airflow path **100**A through the circulation opening **108** as recirculated air W**3**, the recirculated air W**3** has higher moisture content than the drying air W**2** blown out. However, since the drying air W**2** is a mixture of recirculated air W**3** and external air (fresh air W**1**) introduced by the external air intake fans **94**A, the drying air W**2** has a lower moisture content than in cases such as an internal recirculation methods, where only internal air (recirculated air W**3**) is used in the drying air W**2**.

In the drying device **90** of the present exemplary embodiment, the hood **110** that partitions the drying air W**2** circulating to the circulation opening **108** and the fresh air W**1** introduced to the airflow path **100**A is provided to the circulation opening **108**.

FIG. **8**A illustrates the results of a simulation of how each type of air flows inside the airflow path **100**A when the hood **110** is not present at the circulation opening **108**. FIG. **8**B illustrates the results of a simulation of how each type of air flows inside the airflow path **100**A when the hood **110** is present at the circulation opening **108**.

As illustrated in FIG. **8**A, it can be seen that when the hood **110** is not present at the circulation opening **108**, the recirculated air W**3** pushes up the fresh air W**1**, with the recirculated air W**3** circulating in the airflow path **100**A and the fresh air W**1** introduced by the external air intake fans **94**A interfering with each other.

On the other hand, as illustrated in FIG. **8**B, it can be seen that when the hood **110** is present at the circulation opening **108**, the fresh air W**1** is not readily pushed up by the recirculated air W**3**, and the recirculated air W**3** circulating in the airflow path **100**A and the fresh air W**1** introduced by the external air intake fans **94**A do not interfere with each other. In the present exemplary embodiment, the flow of air in the airflow path **100**A is not disrupted, and the mixture ratio of the fresh air W**1** and the recirculated air W**3** can be made uniform along the length direction L of the airflow path **100**A, since the recirculated air W**3** and the fresh air W**1** do not interfere with each other.

Note that this simulation employs an embodiment wherein external air intake fans are provided at both end openings of the airflow path.

As illustrated in FIG. **7**B, in the drying device **90** of the present exemplary embodiment, the recirculated air W**3** taken into the airflow path **100**A through the circulation opening **108** hits the hood **110** (the vertical side **110**B) that faces the circulation opening **108**, and the airflow direction is deflected towards the fans **104**A side. The fresh air W**1** introduced to the airflow path **100**A from the external air intake fans **94**A hits the sealing plates **110**C and is not introduced inside the hood **110**. Accordingly, the recirculated air W**3** circulating inside the airflow path **100**A and the fresh air W**1** introduced by the external air intake fans **94**A start mixing together in the vicinity of the fans **104**A, allowing the mixture ratio of the fresh air W**1** and the recirculated air W**3** to be made more uniform along the length direction L of the airflow path **100**A than in cases in which the sealing plates **110**C are not present.

Moisture content increases at the first horizontal conveyance path **70**A downstream side of the airflow path **100**A, by the amount of moisture evaporated from the paper P as drying progresses. In the drying device **90** of the present exemplary embodiment, the circulation opening **108** is formed at the first horizontal conveyance path **70**A upstream side of the airflow path **100**A. Accordingly, drying air W**2** (recirculated air W**3**) can be taken into the airflow path **100**A through the circulation opening **108** with a lower moisture content than in cases in which the circulation opening **108** is formed at the first horizontal conveyance path **70**A downstream side of the airflow path **100**A.

In the drying device **90** of the present exemplary embodiment, the circulation opening **108** is formed with a size such that the respective plural fans **104**A provided along the length direction L take in the recirculated air W**3** evenly. Accordingly, the amount of recirculated air W**3** contained in the drying air W**2** that is blown onto the paper P can be made more even across the width direction.

In the drying device **90** of the present exemplary embodiment, since fresh air W**1** is introduced from both sides of the airflow path **100**A by the external air intake fans **94**A and collides in the middle of the airflow path **100**A. More uniform flow (see FIG. **7**A) is achieved than in cases where fresh air W**1** is introduced at one side of the airflow path **100**A (see FIG. **9**A). Accordingly, the amount of fresh air W**1** contained in the drying air W**2** blown onto the paper P by the fans **104**A can be made more uniform across the width direction.

As illustrated in FIG. **6**, in the drying device **90** of the present exemplary embodiment, the airflow rate of the drying air W**2** is accelerated and the water vapor removal efficiency is improved due to providing the drying air blowing nozzle **96** below the fans **104**A.

In the drying device **90** of the present exemplary embodiment, since the airflow path **100**A disposed inside of the circulating chains **64**C protrudes in the width direction out from between the chains **64**C, external air can be introduced even though the chains **64**C are present.

The inkjet recording apparatus **10** of the present exemplary embodiment includes the drying devices **90** described above, and the inkjet heads **56**C, **56**M, **56**Y, **56**K, that jet ink onto the recording face of the paper P to render an image, provided at the first horizontal conveyance path **70**A upstream side of the drying devices **90**. The recording face of the paper P jetted with ink from the inkjet heads **56**C, **56**M, **56**Y, **56**K can accordingly be dried uniformly across the width direction by the drying devices **90**.

The inkjet recording apparatus **10** of the present exemplary embodiment also includes the controller **98** that controls the

airflow rate of the external air intake fans **94**A according to the amount of ink jetted onto the paper P. The controller **98** accordingly controls, for example, to reduce the airflow rate when the jetted ink amount is lower than a standard value, and controls to increase the airflow rate when the ink jetting amount is denser than a standard value. Energy efficiency of the external air intake fans **94**A is thereby raised whilst also drying the paper P reliably.

MODIFIED EXAMPLES

Detailed explanation has been given regarding a particular exemplary embodiment of the present invention, however the present invention is not limited to this exemplary embodiment and it would be clear to a practitioner skilled in the art that various exemplary embodiments are possible within the scope of the present invention. Appropriate combinations from the plural exemplary embodiments described above may also be implemented. Appropriate combinations with the following modified examples may also be implemented.

For example, explanation has been given regarding a case wherein the airflow path **100**A extends in a direction orthogonal to the first horizontal conveyance path **70**A, however it is sufficient for the airflow path **100**A to intersect with the conveyance path.

As illustrated in FIG. **9**A, a configuration may be adopted wherein fresh air W**1** is introduced into the airflow path **100**A with an external air intake fan **94**A only provided at one side of the airflow path **100**A. In such cases, the rate at which drying air W**2** blown onto the paper P from the fans **104**A provided along the length direction L of the airflow path **100**A can still be made uniform across the width direction since the fresh air W**1** flows in the airflow path **100**A at the introduction strength. Note that in such cases, the other side of the airflow path **100**A may be closed off, however it is preferable for the other side of the airflow path **100**A to be open, as illustrated in FIG. **9**A, in consideration of an internal pressure increase that might arise.

As illustrated in FIG. **9**B, the external air intake fan **94**A may be provided to a first side of the airflow path **100**A, and an external air discharge fan **120** may be provided to the other side of the airflow path **100**A to discharge the external air (fresh air W**1**) introduced into the airflow path **100**A. In such cases, the fresh air W**1** travels through the airflow path **100**A with a desirable strength, and the rate at which the drying air is W**2** blown onto the paper P by the fans **104**A provided along the length direction L of the airflow path **100**A can be made uniform across the width direction. Interference within the fresh air W**1** and contact with the path walls can be avoided in comparison to the flow of fresh air W**1** illustrated in FIG. **7**A, and disruption of the fresh air W**1** can be suppressed.

Explanation has been given of a case in which the external air intake fans **94**A are axial-flow fans, however centrifugal fans may be employed. Blowers may be used in place of fans to introduce external air, and what is referred to as a bladeless fan, that does not have revolving blades, may also be employed.

Explanation has been given regarding a case where the circulation opening **108** is provided to the airflow path **100**A, however the circulation opening **108** may be omitted. Explanation has also been given regarding a case where the hood **110** is provided to the circulation opening **108**, however the hood **110** may be omitted. Note that if the circulation opening **108** is provided but the hood **110** is omitted, the flow of fresh air W**1** in the airflow path **100**A is liable to be disrupted. However even such cases enable drying air W**2** to be blown onto the paper P from the heating and blowing section **102** at a more uniform rate across the width direction than cases in which the external air intake fans **94**A are not provided.

Explanation has been given regarding a case in which the circulation opening **108** is provided to the side wall **100**D that is on the first horizontal conveyance path **70**A upstream side of the duct **100**, namely the wall on the first horizontal conveyance path **70**A upstream side of the airflow path **100**A. However the circulation opening **108** may be provided to the wall on the first horizontal conveyance path **70**A downstream side of the airflow path **100**A. Moreover, the circulation opening **108** may be provided to an upper wall of the airflow path **100**A, as illustrated in FIG. **10**A. However, more drying air W**2** (recirculated air W**3**) can be taken in through the circulation opening **108**, if the circulation opening **108** is provided on the first horizontal conveyance path **70**A upstream side or downstream side (namely, on the conveyance direction D sides) of the airflow path **100**A since there is less distance between the first horizontal conveyance path **70**A and the circulation opening **108**. Moreover, drying air W**2** can be taken in at a higher temperature when so configured.

Further, as illustrated in FIG. **10**B, circulation openings **108** may also be respectively provided to the first horizontal conveyance path **70**A downstream side wall and upstream side wall of the airflow path **100**A. Explanation has been given regarding a case wherein the circulation opening **108** is provided at a height direction central portion of the airflow path **100**A, however the circulation opening **108** may be provided to a height direction bottom end portion (the end portion on the heating and blowing section **102** side) of the airflow path **100**A, as illustrated in FIG. **10**C. In such cases, more drying air W**2** (recirculated air W**3**) can be taken into the circulation opening **108** since there is less distance between the first horizontal conveyance path **70**A and the circulation opening **108**. Moreover, drying air W**2** can be taken in at a higher temperature. The recirculated air W**3** that has entered the airflow path **100**A through the circulation opening **108** and the fresh air W**1** are also taken into the fans **104**A with hardly any time for the recirculated air W**3** and the fresh air W**1** to mix, since the distance between the circulation opening **108** and the fans **104**A is reduced. The flow of the fresh air W**1** is accordingly not disrupted even when the recirculated air W**3** enters the airflow path **100**A.

Explanation has been given of a case in which the hood **110** includes the flange **112** and the two sealing plates **110**C, however the flange **112** or either one of the two sealing plates **110**C may be omitted from the hood **110**. The fresh air W**1** does not readily enter the hood **110** as long as there is one sealing plate **110**C provided to the hood **110**.

Explanation has been given of a configuration of the hood **110** (with the hood **110** bending around at a right angle) similar to that illustrated in FIG. **6**. However as illustrated in FIG. **11**A, a configuration may be employed wherein the hood **110** is inclined from an edge portion of the circulation opening **108** towards the fans **104**A. Also, as illustrated in FIG. **11**B, a configuration may be employed wherein the hood **110** is inclined so as to describe a line curving from the edge portion of the circulation opening **108** towards the fans **104**A. As illustrated in FIG. **11**C, a configuration may be employed wherein the hood **110** is inclined from the edge portion of the circulation opening **108** towards the fans **104**A in a concertina pattern.

Although not shown in the drawings, the faces of the sealing plates **110**C facing the external air intake fans **94**A may be inclined towards the fans **104**A side. In such cases, the fresh air W**1** hitting the sealing plates **110**C can flow straight into the fans **104**A, making the flow of the fresh air W**1** less readily disrupted overall.

The evaporated moisture in the first horizontal conveyance path **70**A may be expelled along with the drying air W**2** to the outside of the inkjet recording apparatus **10** by an exhaust section, not shown in the drawings. In such cases, the amount of moisture contained in the recirculated air W**3** can be suppressed.

Explanation has been given regarding a case wherein the drying devices **90** are provided further to the conveyance direction D downstream side than the inkjet heads **56**C, **56**M, **56**Y, **56**K, however the drying devices **90** may be provided further to the conveyance direction D upstream side than the inkjet heads **56**C, **56**M, **56**Y, **56**K. In such cases, the moisture in the paper P itself and the moisture in the process liquid are dried, instead of the moisture in the ink jetted onto the paper P being dried. In cases where the moisture in the process liquid is dried, the drying devices **90** may for example be reemployed in the process liquid drying units **50**.

Explanation has been given of a case wherein the cross-sectional profiles of the duct **100** and the airflow path **100**A are respectively rectangular shaped, however triangular, pentagonal and circular cross-sectional profiles are also possible. The shape of the duct **100** and the airflow path **100**A as viewed from above may be configured as a V-shape along the first horizontal conveyance path **70**A.

Explanation has been given of a case wherein plural of the fans **104**A are provided along the length direction L of the airflow path **100**A, however configuration may be made wherein a single fan **104**A is provided extending in the length direction L of the airflow path **100**A. In such cases, for example a cross-flow fan may be employed for the fan **104**A.

In the above exemplary embodiment, an example has been given of a configuration employing CMYK standard colors (four colors), however combinations of the color of the inks and the number of colors are not limited to those of the exemplary embodiment, and pale or dark inks, or spot color inks may be added as required. For example, configuration may be made with added inkjet heads for jetting light inks such as light cyan or light magenta. There is no particular limitation to the disposal sequence of each of the inkjet heads.

In the above exemplary embodiment, the inkjet type inkjet recording apparatus **10** that employs ink is given as an example of an image forming apparatus. However the jetted liquid is not limited to inks for image recording or text printing, and various jetting fluids (droplets) may be applied provided that they are liquids employing a solvent or dispersion medium that permeates a recording medium.

Explanation has been given of a case in which the amount of ink jetted onto the recording face of the paper P is detected by the ink quantity detection sensor **97** and the airflow rate is controlled. However the airflow rate may be controlled by calculating the ink jetting amount based on dot data generated from image data.

Explanation has been given of a case where the hood **110** and the duct **100** are separate bodies, however the hood **110** may be formed integrally with the duct **100**.

What is claimed is:

1. A drying device comprising:

an airflow path extending in a direction intersecting with a conveyance path of a recording medium along a longitudinal direction of the drying device;

an external air intake section that introduces external air into the airflow path; and

a heating and blowing section provided to the airflow path that heats external air introduced into the airflow path and blows drying air onto a front face of the recording medium being conveyed on the conveyance path,

wherein the heating and blowing section is configured to blow the drying air such that the rate at which drying air is blown onto the recording medium is uniform across the width direction of the recording medium,

wherein a circulation opening is formed along the length direction of the airflow path, and

wherein the circulation opening comprises a partitioning plate that partitions recirculated air that is drying air recirculated to the circulation opening and external air that has been introduced into the airflow path.

2. The drying device of claim **1**, wherein:

the partitioning plate has two end portions;

the partitioning plate comprises a horizontal side extending horizontally towards the inside of the airflow path and a vertical side extending from a leading edge of the horizontal side towards the heating and blowing section; and both end portions of the partitioning plate are closed off with sealing plates.

3. The drying device of claim **1**, wherein the circulation opening is formed to the conveyance path upstream side of the airflow path.

4. The drying device of claim **1**, wherein: the heating and blowing section comprises a plurality of axial fans provided along the airflow path length direction that take in external air that has been introduced into the airflow path and recirculated air that has been recirculated to the circulation opening and blows out the combined air; and a heater that heats air blown from each of the axial fans to produce the drying air; and the circulation opening is formed with a size such that recirculated air is taken in uniformly by each of the axial fans.

5. The drying device of claim **1**, wherein the external air intake section is provided at both sides of the airflow path.

6. The drying device of claim **1**, wherein the heating and blowing section comprises a constricted opening that blows drying air onto the front face of the recording medium.

7. The drying device of claim **1**, wherein a gripping member that grips the recording medium and conveys the recording medium on the conveyance path is attached to a moving member that travels in a circuit around the outside of the airflow path and the heating and blowing section.

8. An image forming apparatus comprising:

the drying device of claim **1**; and

a liquid droplet jetting head that is provided to the conveyance path upstream side of the drying device and that jets liquid droplets onto the recording medium and renders an image.

9. The image forming apparatus of claim **8**, wherein: the external air intake section comprises a fan; and the image forming apparatus further comprises a controller that controls the airflow rate of the fan according to the liquid droplet amount jetted onto the recording medium.

10. The drying device of claim **1**, wherein the heating and blowing section comprises:

a plurality of fans disposed in the longitudinal direction of the drying device, the plurality of fans blowing the drying air onto the recording medium.

11. The drying device of claim **10**, wherein the circulation opening is formed with a size such that the respective plurality of fans takes in the recirculated air evenly.

12. The drying device of claim **1**, further comprising:

an external air intake fan provided to a first side of the airflow path; and

an external air discharge fan provided to the other side of the airflow path to discharge the external air introduced into the airflow path.

* * * * *